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CURRENT LITERATURE

BOOK REVIEWS

Individuality in organisms

Continuing his important and illuminating contributions to philosophical biology, CHILD[1] presents in clear and masterly fashion a new conception of the nature of the individuality of organisms which he has developed through many years of investigation of development and reproduction in the lower animals. The book deals with the very fundamental problem of the nature of the unity and order in the organism, the constancy and course of development, the maintenance of individuality in a changing environment, and the processes by which physiological isolation and reproduction occur. As the new theory of individuality applies to plants as well as to animals, and as much supporting evidence has been obtained from the study of plants, the discussion will prove to be extremely valuable to botanists as well as zoologists, and to all who are interested in the philosophical aspects of biological discussion.

The first chapter discusses the problem of the nature of individuality, which resolves itself into the problem of the nature, origin, and maintenance of the definite space and time relations existing among the reactions occurring in the fundamental reaction system, the protoplasm. A new dynamic theory of the origin and nature of organic individuality is presented in the second chapter. The way is prepared for it by a critical consideration of various theories which have been advanced in the past, such as the corpuscular theories of WEISMANN and others, which necessitate the assumption of an ordering principle or entelechy, the dualistic theories, physico-chemical hypotheses, chemical correlation hypotheses, theories of polarity and symmetry, etc.

The organic individual is conceived to be a system of relations between the protoplasmic substratum and the chemical reactions of metabolism; and the foundation of organic unity, according to CHILD, is the transmission of dynamic change of some kind through the protoplasm. The essential features of this dynamic conception of individuality are simple, and are presented with convincing force and clearness. An undifferentiated mass of protoplasm which has a uniform rate of metabolism in all its parts, and which is capable of becoming an individual, forms the starting-point. This mass is acted upon at some point by external factors which act as stimuli, with the result that metabolism is increased at the point of stimulation. In this purely mechanistic way we have established a region of relatively high metabolic rate in the undifferentiated protoplasmic mass. From this point of high metabolic rate there is a radiation of dynamic change over the surface or through the mass of protoplasm. It is a transmissive, not a transportive, change, and in some way involves an increase in metabolic activity as it spreads over or through the protoplasm. In other words, there is a wave of increased chemical activity spreading away from the point of impinging stimulus.

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[1] CHILD, C. M., Individuality in organisms. 12mo. pp. x+213. The University of Chicago Press. 1915. $1.25.

This metabolic change cannot be transmitted to indefinite distances, for the intensity of the metabolic change decreases with transmission. This transmission-decrement partly determines the limits of transmission. Other factors upon which the limit of transmission depends are the intensity of the original stimulus and the relative conductivity of the protoplasm. The limit of transmission determines the size limit of the individual, for parts that lie beyond the transmission limit remain physiologically isolated.

Momentary action of the stimulus may lead only to a temporary increase in metabolic rate at the point of origin, but prolonged or frequent excitation may lead to more or less permanent changes in the protoplasm, chief among which is an increased irritability. The greatest increase in irritability occurs in the region of highest metabolic rate, which is the region of stimulus, and is progressively less in regions of lower and lower metabolic rates, reaching zero at the limit of transmission. Thus we may have established a gradient in the condition of the protoplasm, an irritability gradient, which constitutes the substratum for a persistent metabolic gradient independent of the local stimulus. For as soon as a persistent irritability gradient is established, uniform stimulation will be followed by a graded metabolism dependent upon the degree of irritability of each axial level. Such persistent metabolic gradients are looked upon as the starting-point of organization. They are factors in determining the direction of growth and differentiation, and are therefore the basis of the space and time relations of development.

The phenomenon of dominance of one part or region over other regions of the organism during development is simply a result of these differences in metabolic rates, levels of high rate dominating and controlling those of lower rate, and the interrelations of the parts of the organism, depending thus upon differences of metabolic rate, constitute the foundation of the unity and order exhibited by it. From this standpoint the organic individual is viewed as consisting of one or more gradients in a protoplasmic mass of specific physicochemical constitution; and the process of becoming an individual is merely the process of establishing the necessary gradients. Such gradients, which arise *de novo* in response to external conditions, and cannot *originate* in any other way, may nevertheless become hereditary and persist through many generations when once established.

This dynamic theory is distinguished by its satisfactory interpretation of organic unity in terms of differences in rate of metabolism and of transmitted change, rather than in terms of hypothetical organization and transportation of chemicals. And, being entirely mechanistic, it has the great merit of offering the possibility of experimental advancement toward a complete solution of the problems of individuality.

The three succeeding chapters present some of the evidence which supports this conception of the origin and nature of individuality. The third chapter presents the evidence for the existence of metabolic gradients. This evidence consists mainly in the demonstration of susceptibility, respiratory, and electric potential gradients in the organism coinciding with the supposed metabolic gradients. Embryological evidence for the existence of axial metabolic gradients, and the developmental gradients in cases of asexual and experimental reproductions are considered. The evidence is varied and extensive, and comes from a study of both animals and plants. It all agrees in showing that axial gradients in dynamic processes are characteristic features of organic constitution.

Chap. iv considers the evidence for the existence of physiological dominance in the process of individuation, in support of the conception that "the organic individual is fundamentally a dynamic relation of dominance and subordination, associated with and resulting from the establishment of a metabolic gradient or gradients." The evidence is obtained principally from experimental reproduction in plants and animals, and demonstrates the independence of apical regions in the developmental process, and the control of the development of other levels of the major axis by this independent apical region. The apical regions are the regions of most rapid metabolism, and they are physiologically dominant over the other subordinate levels.

Chap. v gives evidence bearing upon the problems of range of dominance, physiological isolation, and experimental reproduction. The experiments deal with the control of the spatial relations of parts and of the range of dominance by altering the length of metabolic gradients; the obliteration and redetermination of axial gradients; the extension of dominance during development; and physiological isolation and reproduction in plants. The final chapter is a general discussion of individuality from the new viewpoint, and considers such topics as the nature of dominance and inhibition, the origin of metabolic gradients and dominance, the relation of morphological differentiation to metabolic rates, the fundamental reaction system (protoplasm), the nature of agamic and gametic reproduction, and closes with a brief but trenchant discussion of such large problems as heredity and evolution from the dynamic standpoint.

An interesting contrast is drawn between animals and plants in discussing the fundamental reaction system. In animals the independent self-determining apical region begins the process of differentiation, and if the self-determined changes go far enough, they result in the formation of a nervous system, physiologically the most stable structure of the whole animal body. The greatest differentiation occurs in the region of highest metabolic rate. But in the plant the apical region remains undifferentiated, and the degree of differentiation increases with increasing distance from the apical point, a situation exactly the reverse of that found in animals. This difference between the animal and plant is traced to a difference in physiological stability of their respective protoplasms. In animals the stable molecules which form nervous tissue accumulate in spite of the high metabolic rate, while in plants the degree of physiological stability is low, and the high metabolic rate of the apical point may mobilize the whole substratum. It is only in regions of lower rate that the accumulations of visible structure can occur. In this contrast we see one of the fundamental differences between the two classes of organisms.

The reader is favorably impressed by the thoughtful style and illuminating manner in which the philosophical discussion proceeds. The dynamic conception of individuality presented in this work seems so reasonable, and the marshalled evidence is so clear and convincing, that it is bound to exert a profound influence on biological thought and theory. The author modestly states that this conception is "manifestly far from being a complete solution of the problem of organic individuality." It is an excellent working hypothesis, however, suggests many lines of experimental approach toward a final solution, and offers an attractive substitute for the unsatisfactory vitalistic conceptions which have held until now so prominent a place in our philosophy of organic life.—CHARLES A. SHULL.

NOTES FOR STUDENTS

Linkage and crossing-over in oats.—SURFACE[2] is continuing in *Genetics* a series of studies in oat breeding of which two former papers have appeared in the Annual Report of the Maine Agricultural Experiment Station. It will be very gratifying indeed if this new journal makes so strong an appeal to geneticists that work of high grade will no longer be buried with such ephemeral literature as that which makes up the bulk of nearly every station report.

In crosses between strains of wild and cultivated oats (*Avena fatua* and *A. sativa*), SURFACE has studied particularly the inheritance of qualitative characters in the flowering glumes. The base of the fertile floret in the wild oat is characterized by a broad callus associated with ease of abscission from the spikelet, whereas the lack of the callus in the cultivated oat is associated with persistence of the floret. First generation hybrids present the callus in an intermediate condition, and in subsequent generations typical Mendelian segregation takes place. There are, therefore, three types of bases, called, for short, "cultivated," "intermediate," and "wild." Perfectly correlated with the "cultivated" base are the almost complete absence of awns on the lower flowering glume, their complete absence from the upper flowering glume, the absence of pubescence from the rhachilla, the slight pubescence at the base of the first floret, and its complete absence at the base of the second floret. Conversely, the "wild" base is perfectly correlated with the presence of well de-

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[2] SURFACE, FRANK M., Studies on oat breeding. III. On the inheritance of certain glume characters in the cross *Avena fatua*×*A. sativa* var. *Kherson*. Genetics 1:252–286. 1916.